SOIL CONSERVATION

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A GOOD LIVING ON 40 ACRES

By A. L. HARRELL [1]

HE found a four-leaf in his crimson clover patch, but he didn't just sit down and wait for Lady Luck to change her attitude—not Bill McClellan. Bill is a Negro farmer of Calhoun County, Ala., and he does admit that having a few four-leaf clovers on his farm "didn't hurt none." There is no question about it, crimson clover has had a lot to do with helping him to make a better living for his family of six from his 40-acre farm.

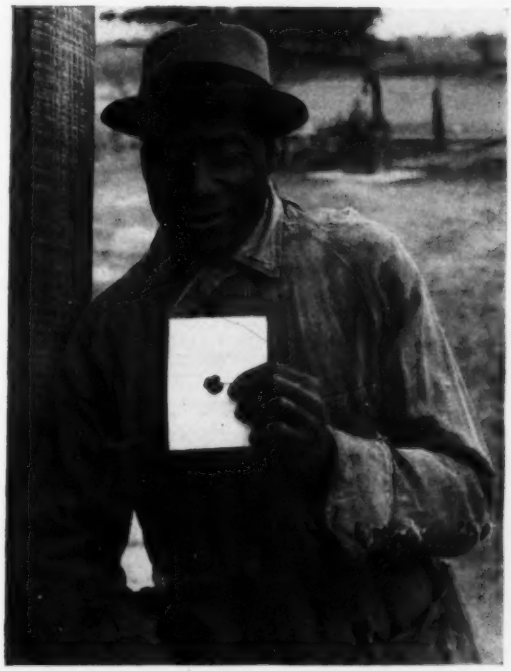
Back in 1935, Bill was producing around 125 bushels of corn on 14 acres, 5½ bales of cotton on 9 acres, and 2 tons of hay from annual crops planted on 4 acres where oats failed. The only other income was from vegetables, milk, meat, and a few chickens raised for home use.

The 40 acres he had bought a few years before with money saved from a railroad job was beginning to look more and more like a bad investment. Bill was about ready to go back to railroading when Soil Conservation Service technicians of the old Anniston demonstration area helped him work out a complete conservation plan for his farm.

Corn following crimson clover began to show a big increase in yields the first year. In 1939 and 1940, he averaged 355 bushels of corn on 12 acres, 5¾ bales of cotton on 6½ acres, 7¾ tons of hay on 7 acres, 60 bushels of oats on 2 acres, 57 bushels of wheat on 2¼ acres, and approximately 2,000 pounds of unhulled crimson clover seed on 2 acres.

At prevailing prices, the total annual value of increased crop yields was $448.13 in 1939 and 1940, with cotton and cotton seed accounting for only $13.88 of it. The largest single item came from the increase of 230 bushels in corn yield.

[1] District conservationist, North Central Alabama Soil Conservation District Birmingham, Ala.



Four-leaf clovers are lucky, all right—especially if you've got plenty of crimson clover on your farm. So says smiling Bill.

Bill "made out" on 125 bushels of corn in 1935 when that was all the corn the farm produced. Then when this crop increased to 350 bushels he sold only 100 bushels and used the remainder on the farm. Although the hay crop in 1939 and 1940 was more than twice what it was in 1935, he sold only a part of the additional yield.

In other words, when corn and hay were more plentiful, the livestock kept on the farm were better

Everybody's well fed and happy on Bill McClellan's farm.

fed than when he had to "make out" on a small amount of feed, and in addition he had a small surplus of feed for sale from his 40-acre farm.

Bill was not growing any winter legumes in 1935, when the conservation plan was worked out for the farm. In 1939 and 1940 he planted approximately 20 acres to crimson clover from seed produced and harvested on the farm. The crimson clover that was turned under accounted to a large extent for the striking increase in corn yield and also provided winter protection against sheet erosion on his cropland.

All the hay produced on the farm in 1935 was from annuals, but the greater portion grown in 1939 and 1940 was from 1 acre of *Lespedeza sericea* and 4.7 acres of kudzu. The kudzu was planted on land that had been abandoned because of erosion. It is estimated that after the kudzu has become well established, an annual hay yield of approximately 10 tons will be realized from the 5.7 acres of *Lespedeza sericea* and kudzu.

In addition to the idle land planted to kudzu, one-half acre of it was converted to woodland, and his pasture was increased by three-fourths of an acre. The pasture has been fertilized and mowed, thus increasing its carrying capacity. Improved terraces were constructed on 32 acres of cropland and a meadow outlet was established to take care of water from the terraces. A wildlife border strip was established between the woods and cultivated land. Kudzu was planted along roadsides to protect banks from further erosion.

Annual lespedeza was seeded on all small grain and could have been mowed for hay if it had been needed. Lespedeza seed is being produced for additional plantings that will be required in the cropping system. No annual lespedeza was grown on the farm before the conservation plan was developed.

This 40-acre farm is making a comfortable living for its owner and his family, and its soil resources are

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Here's Bill McClellan sowing seed "with a heavy hand." You can do that, he says, when you grow the seed yourself.

83,000 PINES ARE PLANTED ON DEWEY HILL

By F. E. CHARLES and EWING JONES [1]

Hunter Hering, chairman of the board of directors, is handed a young pine tree by the Grand Haven postmaster.

Good example of community teamwork: B. P. Sherwood, bank president; Paul Hostetter, general chairman of the tree-planting bee; Ted Bolt, bank president; Leo R. Arnold, county agricultural agent.

DEWEY HILL, an 80-acre sand dune at the mouth of the Grand River on the Michigan west coast, doesn't mean much, as such, to the Nation as a whole.

But on April 19, the people of Grand Haven and the surrounding area, to whom Dewey Hill means very much indeed, staged a wholesale tree-planting bee that made this dune a symbol of the spirit that pervades each of Michigan's eight soil conservation districts—community cooperation.

Nearly a thousand men, women, and children, met on that day on that hill to plant 83,000 little pine trees to stabilize the shifting sands that cost the Government hundreds of thousands of dollars and which threaten to choke the city's harbor. The hundreds of men, women, and children—school teachers, farmers, housewives, Boy Scouts, and Girl Scouts, bankers and barbers and factory workers—showed that community cooperation could bring results.

Planting of the trees was accomplished in the face of obstacles. For 48 hours before the event, those in charge had scanned the skies and hoped for fair weather. Even before school children began planting at 9 a. m., however, it was drizzling. At 11 a. m., thunderstorms sent them scurrying for cover. It continued to rain until 1:15, then almost stopped. Many a tired committeeman was hoping that the rain might halt for the beginning of the parade at 1:30.

As the band led hundreds of tree-planters, spades on shoulders, down Main Street, the heavens opened. The downpour came in sheets and waves. The tree planters marched down to the foot of Main Street, across a 400-foot pontoon bridge, up the steep and sandy slopes of Dewey Hill. Gales blew in from Lake Michigan, drenching men, women, and children.

Photographers' flash bulbs popped all over Dewey Hill. They showed H. H. Bennett, Chief of the Soil Conservation Service; the Reverend Mr. J. R. Euwema, Grand Haven pastor; an 85-year-old enthusiast—all making their contributions to the reforestation effort.

The trees had been furnished by the city, which also staged a barbecue. Key farmers from the West Ottawa Soil Conservation District and Soil Conservation Service personnel gave technical direction. County Agricultural Agent Leo R. Arnold was

[1] Division of Information, Ohio Valley Region, Soil Conservation Service, Danytt, Ohio.

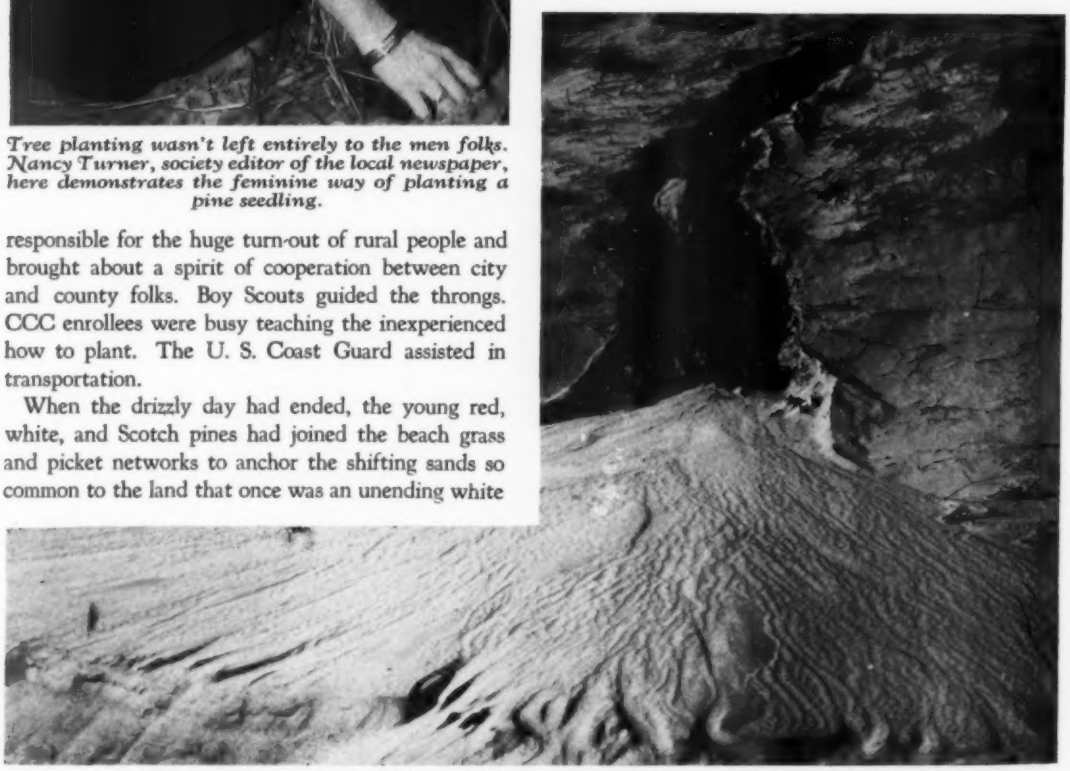
Tree planting wasn't left entirely to the men folks. Nancy Turner, society editor of the local newspaper, here demonstrates the feminine way of planting a pine seedling.

responsible for the huge turn-out of rural people and brought about a spirit of cooperation between city and county folks. Boy Scouts guided the throngs. CCC enrollees were busy teaching the inexperienced how to plant. The U. S. Coast Guard assisted in transportation.

When the drizzly day had ended, the young red, white, and Scotch pines had joined the beach grass and picket networks to anchor the shifting sands so common to the land that once was an unending white pine forest. There was some follow-up work to be done to complete the planting job thoroughly. Businessmen, farmers, CCC-camp enrollees, and others saw to these details before another week had elapsed. Compensating for the discomfort of the weather was the fact that the moisture proved to be fine for the trees which undoubtedly would have suffered had the day been hot and dry.

Dewey Hill is one of the largest dunes along the coast. Sporadic efforts have been made in the past to plant grass and trees, but little headway had been made. Long ago, an important portion of Grand Haven was located there. But the dune kept shifting. Eventually most of those living on the north side of Grand River were forced to abandon their homes. The old railroad station now lies buried far below the countless tons of sands that blow with the slightest wind. The coast guard dredge, *General Meade*, or the "sand-sucker" as they call it, became a familiar sight as it cleared the harbor each year. The sand kept on blowing into the river, washing down from plowed fields upstream.

Directors of the West Ottawa Soil Conservation



Water erosion on Dewey Hill—witness this alluvial fan—causes plenty of havoc.

Looking toward Dewey Hill from the city of Grand Haven. It costs U. S. Engineers approximately $25,000 a year to dredge this harbor.

IF we of the United States are ever to succeed in conserving our natural resources for prolonged, productive use, we will need the cooperation of a great many people—farmers, city people, teachers, business men, and all the others. What the citizens of Grand Haven and Ottawa County are doing here today is an example of what I mean.

This is an event unparalleled in American history. For the first time on such a large scale, Americans from many walks of life are turning their cooperative, community energies to the business of conservation instead of the business of exploitation. Instead of burning trees, we are planting them. Instead of leveling, we are building.

In a world torn by war, the continuing will of Americans to build—instead of destroy—is a matter of monumental importance. The story of what is happening in Grand Haven today should be carried from coast to coast, and beyond our borders. It is at once a symbol of American spirit and evidence of the American will—without compulsion—to build and rebuild the strength, permanence, and productivity of this nation.—H. H. BENNETT, Chief, Soil Conservation Service, at Grand Haven, Mich., April 19, 1941.

District, first to be formed in Michigan, have a more optimistic view now. They believe that this concerted, this carefully planned and carefully supervised tree-planting bee, will put an end to the shifting sands. Dewey Hill, most of which is now owned by the city, is expected to become a forest—a symbol of community cooperation.

Reforestation is not the only means of combating erosion in the district, Hunter Hering, chairman of the board, is quick to tell you. A study of the work program, and of the cooperative agreements already signed by more than 350 farmers, bears him out.

The district has hilly areas in the dune sections along Lake Michigan. Those are sandy soils. The district has muck and rolling clay; it has plenty of good land, plenty of bad. From 50 to 70 percent of its 132,000 acres are blow soil or potential blow soil, and 60,000 acres, according to general agreement, should be in timber.

Let's examine some of the agreements. We find that, for one thing, liming is advocated, and there is plenty of marl in the district. Four marl beds have been opened, and nearly 7,000 yards sold to cooperators at cost. Liming—through cooperation.

Improved crop rotations are being used on all cultivated land. They include legumes to build up fertility of the soil, and are planned to keep the land under cover as much as possible.

Strip cropping is used even on the level land—as protection against the wind. Contour cultivation is practiced. Winter cover and green manure crops are included, pastures are being improved, sod waterways are being installed. Sixty-seven miles of windbreaks have been established. Yes, Hering is right: Reforestation is but one phase of the cooperative attack upon soil erosion in the land of shifting sands.

Cooperation continues to dominate the activities of the wildlife program, in which the district cooperates

with the North Ottawa Rod and Gun Club and the Holland Fish and Game Club. The Rod and Gun Club has helped out by furnishing a seeder and cultivators for the nursery, and in cooperation with the district has started a campaign against burning. The club also is aiding the district in obtaining a fire tower. One hundred and seventy-five thousand shrubs for wildlife food and cover were planted, and numerous feeding stations were established through the winter.

At the outset, tree planting was handicapped to some extent by lack of sufficient quantities of planting stock of desirable species. Cooperation again: The district established its own nursery with an annual output of more than 2,000,000 trees. Frank Garbrecht, one of the directors, donated the land. Moreover, a number of farmers were encouraged to grow their own tree planting stock from seed. At least 65 landowners now have small private nurseries.

The directors have tapped many sources of assistance other than the Soil Conservation Service. There are the two conservation clubs mentioned, the Civilian Conservation Corps, the Agricultural Extension Service, the Grand Haven Chamber of Commerce, State Conservation Department, county and township highway officials, public schools, county board of supervisors, the U. S. Forest Service, University of Michigan, Agricultural Experiment Station, 4-H clubs, many local organizations, and individual business concerns.

The reforestation of Dewey Hill was but a symbol—a symbol of community cooperation. But farmers of the West Ottawa Soil Conservation District are convinced that the democratic solution will work.

GOOD LIVING ON 40 ACRES

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being conserved through a sound land-use plan with every part of the farm utilized according to its capability. There is not a waste acre on the farm and the soil-conserving vegetation that is being grown for the protection of land against erosion is augmenting the supply of forage, improving the fertility of the soil, and increasing both acre and total yields of the various crops.

Like most good farmers, Bill is a good citizen. He is a leader among members of his own race in his community and has been directly responsible for several conservation plans that have been developed on neighboring farms first in cooperation with the Soil Conservation Service project and more recently with the soil-conservation district of which his community is a part. His farm has been visited by numerous groups of both white and colored farmers and the excellent demonstration of what can be done on a small acreage has encouraged many of them to apply for assistance in developing conservation plans for their own land.

Bill McClellan has proved to the satisfaction of those who have visited his farm that it is possible to develop a sound farm program on a small acreage without large cash outlay. Through the wise use of his limited financial resources, he has increased the value of his property and has made his farm produce a much larger income than he was receiving before his conservation plan was established.

GEOLOGIST

(*Continued from p. 306*)

a garden. A washing machine was acquired, to serve its own purpose as well as provide power for a bean huller. The bean huller was the wringer. Cloth strips were used to separate the rollers enough to allow hulls to pass but retain the beans. When the beans were mature, they were picked and not allowed to dry; they were scalded, run through the wringer, and then canned. Large fresh soft beans thus were on the shelf instead of hard starchy beans that required soaking and hours of cooking.

After about five years of farming, less several months of occasional calls for geologic work, times began to be better. In 1937 a good offer for geological work appeared. In discussing it Mrs. Oakes said, "Malcolm, I have kept a careful account of expenses and income during the last 5 years. I have accounted for everything in terms of what food, clothes, and necessities would have cost had we lived in town, and have added to that the income from produce we sold. Just now, we have an income equivalent to $2,000 a year in town, and if you can't get an offer for more, I say stay on the farm."

An income of $2,000 from that hilly, red, sandy, gullied, blackjack country east of Edmond! I know the country. I have been through it before roads were paved and afterward. I have hunted in it and fought fire in the blackjacks. It seems unbelievable that anyone could make a success on a farm in such an area. Conservation is worth the energy, trouble, and time, if intelligently planned, isn't it?

Another offer for geologic work was for more than $2,000 and a year or so later the farm sold for more than Malcolm Oakes paid for it. The beans and other canned produce lasted 2 years. I wonder if the farm still produces an income equivalent to $2,000 a year.

Devoting work hours to waging war against soil erosion, CCC enrollees in camps supervised by the Soil Conservation Service are spending leisure hours studying to become replacements in the industrial defense program. To meet the needs of industries producing defense materials, CCC camps are redoubling efforts to make training timely.

Now added to the curriculum of the SCS camp at Vista, Calif., is a course in aviation mechanics which is approved by aircraft industries. The course is taught by an instructor furnished by the Escondido High School, and requires 200 hours—three months enrollee leisure time—to complete.

Illustrations show enrollees, (1) at work during regular hours, constructing a rock masonry dam as a part of the water facilities work of the Service. Leisure hours at the Vista camp find future aviation mechanics (2) learning to roll metal used in airplane bodies, (3) studying job specifications, and (4) reassembling a Wright cyclone engine.

NEW TILLAGE METHODS CITED BY H. H. BENNETT

(From the printed record of hearings before the Subcommittee of the Committee on Appropriations, House of Representatives, considering Department of Agriculture Appropriations for 1942)

Mr. CANNON. Tell us about this provision for the Soil Conservation Service.

Dr. BENNETT. Before we go into the financial details, Mr. Chairman, I wonder if I could show you a couple of plows I have here. This will show you something of the type of progress being made in our work.

Method of Controlling Crop Residue as Protective Cover to Ground

We have made decided progress in the control of erosion, with the funds given us by Congress, by using all the preventive measures we know about on the different kinds of land we have in the United States that need treatment, but we find that the best we can do generally does not provide complete control. We are now getting around 85 to 90 percent of effectiveness with respect to the control completed; now we must close the gap between 90 percent and 100 percent in effectiveness of control. To date we have used for the most part such measures as strip cropping, contour cultivation, crop rotation, gully control, and many others. But I think now we must go into a new type of agriculture in the United States. Generally, we have been plowing under the crop residues left on the land, such as wheat stubble, for example, and the residues of other crops. We have been turning everything under in preparation for the next crop, thus exposing the bare soil to the rain and wind. Now, with this new type of agriculture that we are trying to put into effect, and in which we are making some real progress, we plow the land in a different way from that employed under the old methods. By this method of plowing, we leave the stubble and other crop residues, as, for instance, wheat straw, on top of the ground.

That is accomplished by using a plow that runs beneath the surface without turning the soil over. This type of plow [exhibiting] indicates what has been done in Nebraska, where we have been carrying on research work and field experiments to find practical ways of carrying out this type of plowing. This [indicating] is the machine or the plow that is doing this type of work. This is a different type of plow from the turnplow. As you will see, it runs almost level. It is set so that the machine really pries the soil up, loosening it, rather than being forced directly through and turning the soil over and all the vegetative cover according to the old method. This machine runs about 5 or 6 inches beneath the surface, cuts off the weeds and leaves the residue on top of the ground. This type of cultivation preserves almost three times as much of the rainfall as is ordinarily preserved by the summer fallow type of cultivation, which turns the trash or residue under. Under this method, the Nebraska experiments showed that the soil contained at the end of the season 9.7 percent of the moisture, where a mulch of wheat straw was used while with the summer fallow method only 3.7 percent of the moisture was conserved. By this method you conserve, as I have said, 9.7 percent of the moisture, while by the basin listing method you conserve only 4.9 percent of the moisture. If there is no plowing of the land, only 1.2 percent of the rainfall is conserved on bare ground. The following table shows the moisture-saving effect of this practice of surface mulching—stubble mulch we call it—together with subsurface cultivation:

Effect of straw mulch and different tillage treatments on the storage of water in the soil near Lincoln, Nebr.

Treatment	Part of 17.9 inches of rainfall conserved (Apr. 23 to Sept. 8, 1938)		Depth of water penetration
	Surface inches	*Percent*	*Feet*
1. Straw, 2 tons on the surface, plowed beneath straw without turning up soil	9.72	54.30	6
2. Straw, 2 tons plowed in, part of subsurface turned up	6.12	34.20	5
3. Land plowed, no straw (summer fallow)	3.71	20.70	4
4. Basin-listed	4.95	27.70	5
5. Bare, unplowed	1.23	6.87	2

Mr. CANNON. What is the comparative percentage of rainfall conserved?

Dr. BENNETT. By this method we conserve more than twice as much of the rainfall as would be conserved by the ordinary summer fallow method, about twice as much as with basin listing, and eight times as much moisture is conserved as would be conserved on bare ground with no plowing at all. Of course, the farmers do not leave the ground bare, but eight times as much moisture is conserved by this method as would be conserved if the surface were bare and no plowing were done.

This recent photograph shows work in Georgia, on a farm near Gainesville. This farmer never plows anything under in the way of vegetative litter, but he has a plow that runs through the soil like this. This plow goes down about 12 inches on this land that was in cowpeas. He can plant corn here by running a little water furrow through the ground. This farmer has practically no erosion, although he not only has erodible soil, but he is cultivating even steeper slopes than are found on the average farm in this Piedmont section. He has used this sort of plow with a high degree of effectiveness. There is no wing on it, and it does not turn the soil over. It is set so that the topsoil and the residue on it is pried up but not turned under. We have one of those plows here.

Mr. CANNON. That is apparently the plow used before Jefferson invented the moldboard.

Dr. BENNETT. I think it is very much like it. At one stage, about Jefferson's time, they had a plow something like this with a small wheel attached in front of it—a sort of colter. This gentleman down in Georgia has a 100-acre farm, and he makes these plows himself. He makes them so that he does not turn under any considerable part of any crop residue or stubble. This is a new type of agriculture that is now gradually being developed in the United States.

Mr. CANNON. That would be of special value in the Missouri Valley, the Mississippi Valley, and Ohio Valley where the soil is practically level and there is little erosion due to washing?

Dr. BENNETT. It is still of importance; it has some additional value in that it reduces leaching somewhat, and it helps greatly to conserve the rainfall.

Mr. CANNON. You consider this a revolutionary appliance and believe it is the coming method of cultivation?

Dr. BENNETT. Yes, sir; and it is being adopted. Incidentally, one gentleman, a Mr. Chase, is now manufacturing the winged plow I showed the committee. He sold some 300 of these plows last year to farmers in Nebraska and neighboring territory, and perhaps other implement manufacturers will also make them.

Mr. CANNON. That would be true if you were planting after soybeans, which pulverize the soil and leave it loose, but how would it operate in a tight sod which has been in pasture for 2 or 3 years?

Dr. BENNETT. I think you would have some difficulty especially in clay types of soil such as we find in regions where the soil is derived from shales. There would be difficulty in the case of the Pierre clay, a stubborn shale-derived clay soil. In such soils this machine would probably not be sufficient to produce the ideal tilth if there were a thick growth of grass on it, but under almost any ordinary condition it does leave an ideal tilth for seeding without further preparation; that is, after summer fallow.

Mr. PLUMLEY. What do you mean by "tilth?"

Dr. BENNETT. That is soil mellowness. It is a spongy condition, or a good mellow condition—spongy, so that you can dig into it with the bare hand.

Mr. PLUMLEY. Looking at that plow, it seems as if there would be a trench driven between the rows. Is that right?

Dr. BENNETT. There is a little trench—scarcely more than the furrows of a grain drill.

Mr. CANNON. Do implement manufacturers recognize the importance of that design?

Dr. BENNETT. Yes, sir.

Mr. CANNON. Are they putting these plows on the market?

Dr. BENNETT. Yes, sir.

Mr. CANNON. Have you issued any bulletins on this new type of cultivation?

Dr. BENNETT. Some papers have been published by the American Society of Agronomy, and we have prepared a bulletin about it.

Mr. CANNON. Will you give them a list of the names of the members of this committee to receive a copy of the bulletins when they are available?

Dr. BENNETT. I will be glad to do so.

Mr. CANNON. You may proceed with your statement, Doctor.

Planting of Trees, Grasses, etc., for Soil-Erosion Prevention

Dr. BENNETT. Here [indicating] is a photograph showing application of that principle of work, near Caddoa, on the Arkansas River, in southeastern Colorado, where the Army engineers are building a great dam as a flood-control and water-conservation dam. They started this project, I think, because down the Arkansas River every spring great quantities of water run to waste from the melting snows in the Rocky Mountains. Nobody gets any good from much of this water. Oftentimes it does a lot of damage on the way to the Gulf, causing troublesome floods. They have an important irrigation agriculture along the Arkansas, and almost every year, many years at any rate, there is plenty of water in the spring but not enough when summer comes. Sometimes upward of half the crops are seriously damaged or ruined because of summer or late-summer scarcity

of water. Year before last, I think, they had a serious situation like this.

In building this dam something like 20 miles of track of the Santa Fe Railroad was to be inundated. The Army engineers asked the Santa Fe officials if they would move their tracks to the adjacent uplands, just to the south. They said in effect, "We cannot move the tracks to the south because of the sand dunes prevalent in that section. The sand will be constantly blowing over the track and we will have a perpetual expense to remove it." They were willing to move the track to the north, but that would have necessitated payment by the Government for building 2 expensive bridges across the Arkansas River. There were also many other expenses that the U. S. Government would have had to bear. Well, one of the Army engineers, as I was informed, advised that they go down to the southern plains section near Dalhart, Tex., to look at some dune-control work that the Soil Conservation Service had carried on there in its research program in an attempt to control wind erosion, and where some 70 dunes had been controlled successfully, mainly by leveling the higher points and putting in adaptable vegetation. So the Santa Fe engineer went down there, investigated the dune work, and agreed to recommend that the company move its track to the south provided the same sort of work be done to control the dunes at Caddoa.

One of our men was assigned to work with the Army engineers on the Caddoa undertaking, and they controlled something over 50 dunes, running up even higher than this one in the photograph [indicating]. When I was there last fall, I saw dunes that were 20 feet high a little while before, which had been stabilized by planting grasses and putting a layer type of wheat straw over the surface of the ground. The perennial grasses, such as rye grass and blue grama-grass, were seeded. They have controlled the problem out there very effectively. When I got there, the Santa Fe Railroad already had not only agreed to move the track but they had prepared to move it. The job was about finished—cuts dug, fills made, and the roadbed about ready for laying the rails. It will all be finished this year. The difficult work is already completed.

The total maximum cost of the dune-control work is estimated to run something under $140,000. I do not think it will run to above $100,000. The saving to the U. S. Government on that one job will be in the neighborhood of $3,000,000, according to my observation and reports gathered ideally. That job was accomplished by the utilization of a modification of this same method referred to under this new type of agriculture—this preserving of crop residues—stubble, straw, and so forth—as a protective cover to the ground.

COOPERATORS APPRAISE CONSERVATION PROGRAM

By C. D. BLACK [1]

WHAT do cooperators think of their farm plans after they have been in operation several years? During the past year a studied effort was made to obtain a fair appraisal from cooperators of Ohio's oldest soil conservation demonstration, the Salt Creek project, which was also one of the first established in the Nation. Part of the survey was conducted by personal interview, the remainder by mailed questionnaires that for the most part could be filled out by simple affirmative or negative answers.

To set up a representative cross section, the cooperators first were classified, or graded, in accordance with their attitudes, types of farms, quality of demonstrations, etc. Cooperators in each grade were then rated proportionately. In all, a total of 135 individuals responded, or nearly 43 percent of all those having cooperative agreements in force when the survey was started.

The survey was divided into five parts, general soil conservation farming, strip cropping, pasture improvement, alfalfa-grass meadows, and woodlands.

Most heartening of the responses in the series of general questions came from the 68 percent saying that their neighbors' attitude toward the program had improved. Nearly 74 percent stated that the program had increased the value of their farms, and 59 percent said it had boosted their incomes. A thumping 88 percent declared that they would continue the plan after the agreement expired, and 56 percent believed no further assistance was necessary.

Strip cropping.—What the farmers think of strip cropping is shown by the following percentage summary of affirmative and negative answers to questions asked them.

[1] Project technician, Ohio Valley Region, Soil Conservation Service, Zanesville, Ohio.

Salt Creek cooperators say that strip cropping increases yields.

	Yes	No
	Percent	*Percent*
Does the practice satisfactorily control erosion?	85	15
Is the practice inconvenient?	39	60
Does the practice increase cropland yields?	75	25
Will the practice be continued?	90	10

Pasture management.—The improvement of permanent pasture has been considered one of the more important phases of the program in the Ohio Valley Region. The cooperators' appraisal of the program in the Salt Creek area disclosed several interesting facts about the pasture problem:

	Yes	No
	Percent	*Percent*
Were results from pasture treatment satisfactory?	85	15
Have you treated more pasture with lime and fertilizer?	31	69
Will you treat more?	85	15
Do you clip pasture?	49	51
Will you clip next year?	65	35

The work that has been done thus far along the line of pasture improvement in this area appears to have met with a fairly high degree of success, but the acreage treated represents only a relatively small proportion of the total pasture on the farms in question. The question therefore arises: What will be the status of pasture improvement in this area in the future? Almost one-third of the cooperators reporting indicate that they have treated additional pasture, and 85 percent will treat more. At first thought this would indicate that decided progress already has been made with the pasture problem and that treatment will progress rather rapidly in the future. Observations show, however, that those who have treated more pasture have done so on a small scale and some have applied only lime, or fertilizer alone.

Although half of the cooperators indicate that they clip pasture and 65 percent intend to do so in the future, the use of this practice is not noticeable in this area. It appears to be spreading, however, and is likely to be somewhat generally adopted in the not-too-distant future.

Alfalfa-grass meadows.—Cooperators' opinions of alfalfa-grass meadows are best shown by further summarizing answers to questionnaires:

	Yes	No
	Percent	*Percent*
Was your alfalfa-timothy or alfalfa-orchard grass meadow satisfactorily established?	82	18
Has the same area been renewed?	28	72
Have you increased the alfalfa acreage on your farm?	58	42
Can alfalfa be renewed without going through a corn crop?	79	21
Was alfalfa-grass meadow the proper use for the area?	86	14
Should alfalfa be grown:		
(1) on a definite area?	61	.....
(2) in the rotation?	22	.....
(3) in both rotation and on a definite area?	17	.....

It will be seen that a large majority of the alfalfa-grass meadows were satisfactorily established. Furthermore, we have noted that many of the 19 percent classed as unsatisfactory in reality were superior to other meadows on the farms in question. This success with such a large number of meadow seedings is somewhat remarkable, considering that only a relatively small number of these farmers ever had grown alfalfa before.

Woodland management.—Of all the trees planted in the Salt Creek area, black locusts were classed by cooperators as most successful from the standpoint of both survival and growth. Pine plantings were rated as second best. The cooperators' opinions of their farm woodlands may be noted in this summary of their answers to 12 pertinent woodland management queries:

	Yes	No
	Percent	*Percent*
Have planted areas been grazed?	9	91
Will you continue to protect from grazing?	85	15
Will you plant more trees?	28	72
Was tree planting the proper treatment?	99	1
Is pasture loss noticeable as the result of fencing established woods from pasture?	19	81
Has this existing woods area been grazed?	10	90
Will you continue to protect from grazing?	83	17
Will you fence off more woods?	5	95
Is natural reproduction abundant?	73	27
Do you anticipate a regular income from the woods?	17	83
Do you plan to harvest timber on the selection basis?	52	48
Is permanent woodland the proper use for the area?	94	6

This alfalfa stand was produced on an eroded field (like the one beyond the fence) formerly covered with poverty grass. The alfalfa is on the farm of a Salt Creek cooperator.

Visits to plantations on a hundred farms by the Muskingum CCC-camp forester showed that about 30 percent of the cooperators had allowed grazing in varying degree. However, only a little over one-fourth of the cooperators appear to be interested in future additional plantings even though in general they agree that such treatment was proper for the areas in question. Although slightly more than half of the cooperators expect to harvest from their woodland on a selection basis, only a relatively small percentage of them expect a regular income from their woods. Although the farmers who are planning to harvest timber on this basis may not have an altogether adequate conception of selective cutting, nevertheless it is likely that they will realize more from their timber sales than will those who continue to use the slash method

TRI-RIVER SOIL CONSERVATION DISTRICT POCAHONTAS, ARK., DECEMBER 31, 1940

(Semiannual report, submitted by the Board of Supervisors)

IN July 1940, the supervisors of the Tri-River Soil Conservation District submitted a semiannual report and commended the different Government agencies and civic organizations on their splendid cooperation with us in our efforts to establish community centers and community leaders for the development of proper land use to lead to a permanent agriculture and a fuller economic farm life for the people. We feel that this has shown wonderful progress. Quoting from our Narrative Report, July 1940:

> It is not for the sake of the soil alone that we attempt to keep our district alive to the fundamentals of good farm practices but for the maintenance of the farm families who take their life from this soil with their own hands. We are firm in our belief in the statement of President Franklin D. Roosevelt that "the soil is truly our first line of national defense" and our strength for the holding of this line constantly becomes greater as new cooperators join our ranks.

With this in mind it is our hope as farmers and supervisors, through our connection with the local leaders, to help prevent what we saw happen in the last great war; that is, the opening up to erosion, by cultivation, of land that should never have been plowed. It is our grave fear, that unless there can be a coordinated effort on the part of all agriculture workers to prevent cultivation of steep slopes, overgrazing of pastures, unmerciful slashing of woodlands, that instead of progress in conservation we will have progress in devastation. We realize the danger of these erosion hazards with the possibility of higher prices due to the national defense program or war itself.

To date, much progress has been made in our district toward soil conservation and establishment of erosion control practices. We are sure that our national agricultural leaders foresee the hazard of increased prices and the way it might become a menace to soil conservation and permanent agriculture. We feel, however, with our present district set-up, with our local leaders and township committeemen, that we are in a position to prevent a tearing down of the progress already made in our district. Our community leaders seem to us to be in just the position to deal directly with the individual farmer in coping with any national emergency that might arise at the expense of the soil.

Since approximately 65 percent of the Tri-River Soil Conservation District is in actual woods or potential woods, it behooves the supervisors to give more consideration to the problem of proper woodland management. The national-defense program has opened our eyes to the value of our farm timber, and we should remember the devastating effect World War No. 1 had

on our timber, and at this time put more stress on the sound management practices recommended by district technicians. Because of the sharp increase in timber prices within the past 6 months, we should impress upon the district cooperators, more than ever, the importance of sustained yield, proper cutting, protection from fire and grazing, cutting damaged and diseased

Numerous streams wind through the Tri-River District. Although not so good as they once were, they still provide some excellent fishing. The supervisors look for still better fishing as soil conservation comes to the aid of such streams as the Eleven River, a glimpse of which is seen here.

trees first, removing trees in such a manner that large openings will not occur. We feel that this can be done better through our community leaders as they can better realize local problems and their opportunities, and can and will give much able assistance to our cooperators.

Another factor we have not overlooked in our woodland management program is the effect of woodland on flood control. This particular phase of the flood control program was emphasized at a recent meeting of the board of supervisors, and some valuable information was received at a meeting, attended by a part of our board, of the Southern States Flood Control Board, held at Hot Springs, Ark., January 1941. Little did we realize that woodlands are the best binders of the soil and the best water reservoirs of all other forms of vegetation. With approximately 190,000 acres of woods draining into Black River, Spring River, Eleven Point River, Current River, and Fourche River, we feel that these woodlands have a real service to render in helping to protect the valleys from destructive floods. We shall do our utmost to instill into district cooperators an understanding of the value of proper woodland management. As of January 1, 1941, 39,564 acres of woodland are under agreement with the district.

The district has been assured of the able assistance of the WPA in 1941, now that most of the WPA projects on "Farm-to-market" roads are nearing completion in our district. We feel that WPA assistance on individual farms is just another link in the improvements of our national agricultural program. It is gratifying to the supervisors of the Tri-River Soil Conservation District to see that our Congressmen realize that there is no such thing as individually owned land, and that basically the Nation owns the land and the holders of particular tracts are only the lessees. By legalizing the use of WPA assistance to aid in conservation work on individual farms, Congress is merely enabling the Government as lessor to step in and help preserve its own property which has been sadly neglected by the holders or lessees who have allowed erosion to wash away valuable soil.

Since the soil is truly our first line of national defense, we welcome the assistance of the Government agency in helping us control erosion and establish permanent agriculture on what is actually the Nation's land leased to the individual.

While the WPA is helping the district in conservation work on the Nation's many farms, we hope our technical personnel in the district will accomplish much in teaching the WPA workers the principles of erosion control and good farm management practices. We know that many laborers now on WPA once farmed their own acreage and lost it through lack of knowledge of proper land use. We hope and believe that the WPA supervisory personnel will take particular pains to assign to conservation projects in the district those men who wish at some future date to return to farming themselves. The supervisors believe that this arrangement for WPA assistance will prove of mutual benefit to all concerned.

Since the supervisors made their last report, approximately 2,400 land owners with a total acreage of

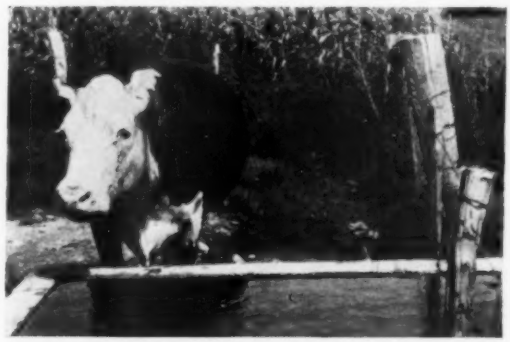
Erosion has forced abandonment of many steep areas that should never have been in cultivation. Too riddled with gullies for pasture, this hillside has been planted to black locust, sumac, and wild plum. The trees and shrubs are to control erosion; black locust trees will do nicely for fence posts; all will provide food and protection for wildlife.

355,000, adjoining the present district, have voted, by an overwhelming majority, to be annexed to our district. The greater part of this new territory is considerably different from our original district. Previously our work has been largely with owners who farmed and lived on their own hill farms. Most of the annexation lies east of Black River and is composed of rolling to bottom lands of a sandy nature which erode very easily both from wind and water.

These farms are large and run more on a plantation style. Here, the majority of the actual farmers are tenants and thus our problem is partially one of landlord and tenant cooperation. We think this will not be difficult, however, as the landlords and tenants realize that it is to the advantage of both to have a long-time lease specifically incorporating erosion control and other farm practices advocated by the district's technical men. This will put the landlord's farm in better condition and will mean more money to the tenant. So we are looking forward to the district as a means of real help to the tenants and owners in this part of the annexation.

From opinions expressed by groups of farmers at recent meetings, it seems that most of the assistance to be requested will be of a technical nature. As we see it, farmers in the new area will need mainly engineering assistance in running strip crop lines, terrace and drainage systems, and agronomic assistance in working out proper cropping and management practices. On that portion of the area where the land is irregularly rolling and mounded, field strips probably will be one of the recommended practices.

Since this annexation is considerably different from the original district both in type of farming and problems offered, we feel that we should attempt a little different method of approach on farm planning in the area, to try for a better solution of the farm problem. We intend to consider each problem area as set up by the county-wide planning committee as an individual unit. After the conservation survey has been made and before the farm planner starts to work on this area, we intend to call a meeting of the local representatives of the various agencies cooperating with the district. With the conservation surveys we can make a careful study of this area. Then, too, we can find out what each agency can do to assist in bettering the soil and economic life of these farmers. With this information, we feel that the farm planner can make a wiser and more complete plan.



Development of watering troughs below stock tanks is one of the approved practices in pasture development. The stock pond gets protection from contamination and from sedimentation. Ungrazed vegetation immediately above the pond stops the soil carried by water.

We intend to set up priority areas in which applications will be received. After the conservation surveys are made a meeting will be called for the farmers in that community. At this meeting will be explained the functions of the district, the part each agency will play in the district program, the land-capability table, and the district agreement. Each farmer will be giver a conservation survey of his farm, colored according to the land-capability table. He will then have an opportunity to review the physical capabilities of his farm and will be able to draw up a tentative plan before the district planner contacts him for the drafting of the final plan.

In another section of our new area the picture is far from bright. We have three townships which present a question for which we have not yet found the answer. These are the townships of Annieville and Ravenden in Lawrence County, and Union Township in Randolph County. These three town-

ships, recently annexed, do indeed give us an economic problem. Practically no one of the small farm owners in these localities has the equipment or finances necessary to carry out even a partial erosion control program. Most of these farms are in such a critical stage of erosion that it is impossible for the owners to make enough income to support their families and they obtain part-time work on the WPA and elsewhere. The land is impoverished, resulting in an impoverished rural population. Here is a situation which truly needs remedying and with all the help now at the disposal of the supervisors we feel that in time we can bring a measure of relief to these special localities where it is so badly needed.

The board of supervisors desired information from people in every walk of life, and for this reason bankers, tax collector, county judge, stockmen, and many others were interviewed for the purpose of determining whether or not the soil conservation district was contributing in any way to the economic life of this community. We wish to quote the sayings of these persons, to wit:

I can see vast improvements made since the farmers have organized themselves into a soil conservation district. They take more interest in their roadsides, bridges, drainage water, and I can see it helps the county in maintenance of their highways in many ways.

REX JOLLY, *County Judge.*
JOE DECKER, *Former County Judge.*

Over 40,000 acres of land have been redeemed by original owners or purchased by individuals, and placed back on the tax books of the county since formation of the Tri-River Soil Conservation District.

BEN A. BROWN,
President, Randolph County Abstract Co.

I have been a livestock trader around Pocahontas for the past 30 years. I saw the pastures and meadows plowed up and put to row crops during the World War boom, and the resulting washing away of the topsoil, and the forming of gullies on most of the sloping fields. Probably no one can appreciate as I can the program of the Tri-River district in rebuilding pastures and meadows that were plowed up. Better livestock are increasing as the pastures and meadows improve, with increased income to the individual farmers, and naturally a greater volume of trading for me.

NOAH PACE.

Our forfeited land sales have become very light and few tracts have been forfeited to the State since this district has been placed in a soil conservation district.

ROLAND MORRIS, *Tax Collector.*

In my opinion the formation of the soil conservation district, with local supervisors and community leaders, has played a big part in reducing loan delinquencies from 50 percent to approximately 5 percent since 1935.

ROY BENNETT,
Secretary-Treasurer, Local Federal Land Bank.

As a resident of Pocahontas, Randolph County, Ark., and acquainted with the Tri-River Soil Conservation District area, I wish to make this statement:

I am employed in the State Land Office at Little Rock, Ark., and in this capacity I have opportunity to note that over 75 percent of the land that heretofore has been forfeited to the State for nonpayment of taxes has been redeemed by the original owner or purchased by individuals. I attribute this to the soil conservation district.

JIM SHIVLEY.

At the local livestock sale in Pocahontas, today, approximately 3,000 head of stock were sold. This is a weekly sale and the increase in livestock definitely shows an increase in pastures. Buyers were present from north of St. Louis, Mo. The sales for the past week amounted to $5,200. Amounts are not available as yet for today's sale.

H. G. MCNABB

Dean Sallee, chairman of the board of stewards of the local M. E. Church, replied in answer to the question, Has soil conservation work affected the church collections? with the remark that this year the church budget was the largest for several years, and that the past year was the easiest for collections since he had been associated with that work; that he felt soil conservation work had helped increase the income of the town to make this possible.

In the approximately 3 years that the district has been in operation, not a single week has passed that our weekly county newspaper, the Star Herald, edited by Mrs. Eunice O'Baugh, has not carried from one to three columns about the work of the district. We wish to acknowledge this valuable publicity and to say that the cooperation of this editor and paper has been of inestimable help in the district's program. Besides these general columns, the paper frequently runs editorials commending the work of the district. At present the Star Herald prints a column headed "Out in the District" devoted exclusively to individual news items of work and happenings among the district's cooperators.

Having enlisted the active support of every agency, corporation and individual in our territory, we feel that the goal of permanent agriculture, founded on soil that will not wash away beneath our feet, will be reached.

F. W. Cox, *Chairman.*
J. D. Wells, *Vice Chairman.*
J. F. Sloan, *Secretary.*
R. S. Rainwater, *Member.*
J. B. Weaver, *Member.*

Report of educational activities, July 1, 1940 to Dec. 31, 1940

Activity	This period	To date
Educational meetings:		
Number	23	362
Attendance	562	10,447
Tours:		
Number	0	11
Attendance	0	393
Demonstrations:		
Number	1	1
Attendance	65	65
Training school meetings:		
Number	0	0
Attendance	0	0
Exhibits: Number	2	5
Radio talks: Number	0	0
News articles: Number	41	276

Report of conservation practices, June 30, 1940, to Jan. 1, 1941

Agreements signed: This period—number, 287; acres, 33,257.5. To date—Number, 1,001; acres, 131,375.
Amendments: This period—Number, 132. To date—Number, 215.
Agreements canceled to date: Number, 9; acres, 1,702.

Practice	Before agreement		Newly planned		Established	
	This period	To date	This period	To date	This period	To date
Border strip (acres)	0	.....	4	27	0	5
Clearing and grubbing (do)	.....	.....	23	29	0	6
Contour cultivation (do)	2,402	5,220	2,402	10,407	2,174	3,067
Contour furrows and ridges (do)	0	0	657	1,627	240	771
Controlled grazing (do)	0	0	12,734	51,674	15,765	24,919
Cover crops (winter) (do)	.....	203	1,304	4,579	2,294	3,087
Diversions (rods)	0	0	6,078	17,264	422	1,358
Drainageways:						
Individual outlets (number)	0	0	356	2,480	23	159
Channels (rods)	0	0	3,611	9,014	307	2,054
Pasture and meadow strips (acres)	0	0	53.2	211	12	59.5
Fencing:						
Constructed (rods)	.....	.....	28,637	116,437	3,751	15,973
Removed (do)	.....	.....	8,425	33,081	1,020	4,750
Fertilizing (acres)	0	0	160	1,175	30	816
Gullies treated (number)	.....	.....	5,975	26,329	266	3,161
Leveling old terraces (rods)	.....	.....	530	5,111	350	1,269
Liming (acres)	.....	.....	71	1,033	25	753
Pasture improvement (do)	.....	.....	5,185	10,094	1,863	3,051
Planting new pasture (do)	.....	.....	9,018	27,521	103	2,919
Planting old pasture (do)	.....	.....	3,056	10,037	150	1,445
Planting new permanent hay (do)	.....	.....	3,121	11,598	964	8,245
Planting woody vegetation (do)	.....	.....	52	338	37	125
Farm road treatment (rods)	.....	.....	3,389	13,661	761	1,402
Rotations approved (acres)	6,346	11,186	3,346	14,927	5,287	7,921
Contour strip crops (do)	.....	.....	870	4,476	117	223
Structures:						
Gully (number)	.....	.....	394	1,590	31	402
Retention (do)	.....	.....	51	69	1	11
Capacity (acre-feet)	.....	.....	115	166.1	3.6	40.3
Fencing or fenced (number)	.....	.....	51	69	1	10
Spring development (do)	.....	.....	8	8	1	1
Terracing (acres)	.....	.....	1,185	4,254	138	1,380
Weed control (do)	.....	78	11,361	28,221	2,089	8,220
Woodland improvement (do)	.....	.....	.....	10	.....	.....
Woodland protection (do)	5,430	24,080	4,430	14,315	7,445	12,231

Land conversion and ownership report, July 1, 1940, to Jan. 1, 1941

Land use	Before agreement	After agreement (planned)								
		Cultivated	Permanent hay	Orchard and vineyard	Pasture or range	Forest range	Woodland	Wildlife	Idle	Miscellaneous
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Cultivated land	30,122.5	19,704	6,122.5	158.5	3,913	.....	23.5	15	.....	186
Permanent hay	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Orchard and vineyard	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pasture or range	14,396.5	679.5	1,131	30.5	12,169	.....	198	40.5	.....	148
Forest range or woodland pasture	6,612	4	13	.....	3,169	.....	3,204	5	.....	217
Woodland	49,997	800.5	363.5	54	12,393	.....	35,627	447.5	.....	107.5
Wildlife	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Idle	28,395.5	2,192.5	4,397.5	80.5	20,700	.....	512	319.5	.....	393.5
Miscellaneous	1,630	20.5	17	60	70.5	.....	.....	3.5	.....	1,458.5
Acres in agreement	131,353.5	23,401	12,046.5	383.5	52,616.5	.....	39,564.5	831	.....	2,510.5
Net changes	.....	−6,721.5	12,046.5	383.5	38,220	−6,612	−10,432.5	831	−28,395.5	880.5

Improper discharge of surface water often damages highways and public lands.

FARM DRAINAGE OPERATIONS FOR THE FARM PLANNER

BY JOHN G. SUTTON [1]

IN bringing drainage into the Soil Conservation Service program many farm planners are meeting a new problem. Some may question how and where drainage fits into a conservation program. To answer this question we must think of drainage not as an end itself, not as a means to speculative land development but as a tool of the soil-conservation program to be used in securing proper use of each acre of land. With this as a general objective, we must apply additional criteria to drainage proposals. Some drainage projects involve soils well adapted for sustained agricultural use, while on others the soils drained are submarginal under existing agricultural conditions. Some drainage jobs are not economically sound; others would be financially sound even without Government assistance or with limited assistance. These criteria may be applied on a farm basis, or to land areas involving few or many farms.

When the farm planner encounters a drainage problem on a farm he must be able to determine its relation to the soil-conservation program, know the effects of drainage on the land, and be able to offer practical solutions to the problem. Drainage of an area may bring into cultivation land not previously cultivated, and on most soils it will improve the productivity of land that has been farmed while inadequately drained. This means increased crop yields to the farmer so that drainage becomes an economic benefit to him and, usually, he will want to secure as much help as possible in draining his wet lands. Some farmers have not had first-hand experience with artificial drainage and its benefits must be explained to them in detail.

[1] Head, drainage and irrigation section, engineering division, Soil Conservation Service, Washington, D. C. The article presented here does not include discussion of drainage of irrigated lands.

Drainage operations contribute directly to the success of erosion-control practices in a number of situations. Probably the simplest to interpret is the physical land problem, or topography, that requires drainage operations to facilitate the application of one or more farm-conservation practices. Three examples of this type of problem are described below:

(1) Tiling of wet spots on a farm is necessary to permit contour cultivation, strip cropping, or terracing.

(2) Spots that become wet as the result of terraces or diversions should be drained.

(3) A drain through bottom land is necessary in order to avoid damage from concentration of water in a terrace outlet or diversion.

Other situations, more complex in nature, include economic considerations which relate drainage operations to erosion control practices as an integral part of farm-conservation plans. The following brief descriptions point out these situations:

(1) Draining or improving the drainage of one part of a farm is necessary to permit the retirement or change to soil-conservation use of a steeper portion of a farm, or to retire land not adaptable to conservation farming.

(2) Drainage is necessary to improve the farm unit or make it sufficient from an economic viewpoint in cases where the farm is not an economic unit after other conservation practices have been applied.

Many drainage problems cannot be solved on a single-farm basis. These often involve outlet or overflow difficulties common to small or large groups of farms. Such problems should be recognized and plans for their solution ought to be developed along with farm planning.

In incorporating drainage into a farm plan its effects on the land and on farming operations should be clearly understood, as should also the connection between effects and degree of drainage obtained. For convenience, degrees of drainage may be expressed thus: The term *excellent drainage* may be applied to land with fine underdrainage (usually tile-drained) and not subject to overflow except possibly in an exceptional flood, say with not less than a 25-year frequency. *Very good drainage* means good underdrainage, and flooding at 3- to 15-year intervals during the cropping season but for such brief periods that crop damage is not great. *Good agricultural drainage* connotes flooding possibly once annually for so short an interval that no extensive crop loss will occur. The surface and underdrainage are sufficiently satisfactory to permit production of good crops in normal years, while only in wet years will crop losses due to inadequate drainage be evident. *Fair drainage* signifies the degree of drainage wherein flooding will occur several times annually in normal years and partial crop losses may be expected once in 3 or 5 years, with only fair crops in a normal year. Lands having "fair" drainage may be well adapted for use as pasture or meadow.

The degree of drainage is controlled by engineers by construction of larger and deeper drains where "excellent" and "very good" drainage are required.[2] If drainage systems are not properly maintained the lands will in time become poorly drained, usually because open drains become clogged with bushy vegetation and silt.

The improvement of farm drainage often indicates a change in land use. For example, it may be desirable to change a poorly drained field or swamp to pasture by providing "fair" drainage, or it may be desirable to change the land use of a pasture area to cultivated field crops by providing "good" agricultural drainage. In planning a farm the farm planner should specify the land use so that the required degree of drainage may be provided insofar as practical.

Other effects of drainage must be given careful attention by the farm planner. It is well established that some legumes do not tolerate high-water-table conditions. We often hear farmers who are working on poorly drained soil make statements such as the following: "Clover will not grow on soggy soil"—"Liming is nearly useless until the soil is properly drained."—"Alfalfa won't do well on wet fields." Such remarks indicate the bad effects of poor drainage on legume crops. Those soil bacteria which inoculate legumes to change air nitrogen into fixed soil nitrogen, so it can be used by the plants, will not thrive in a wet soil. The legume plants take a large amount of nitrogen from the air, working in symbiotic relation with these bacteria. It is evident that complete aeration of root zones is even more important for some legumes than for other crops. However, other legumes, such as soybeans, do tolerate wetter soils. Since legumes are generally fundamental to a soil-conserving rotation, it is evident that drainage conditions must be given careful study in developing the cropping rotation of a farm plan.

Another effect of poor drainage is the winter kill or injury of plants that go through a winter. Where soil is saturated the recurring freezing and thawing often pushes individual plants almost out of the ground so that they are killed or injured. Poorly drained spots in wheat and alfalfa fields can be picked out in the spring because of the effects of winter kill.

Good underdrainage is of primary importance and may be secured even on some of the heavier clays by tile drains. Underdrainage results in a lowering of the water table and this sets in motion many beneficial processes: Water leaves the soil earlier in the spring so that fields can be plowed and planted; in a well-drained field the percent of seed germination is higher and the resultant stand is superior.

Good drainage, with proper rotations and cultivation, means good tilth to the soil. Good drainage permits cheaper cultivation. In poorly drained fields, farm machinery must go around wet spots and this brings up the cost of cultivation. The well-drained field has a deeper root zone and also better aeration of the root zone, a condition essential to proper plant growth. The deeper root zone permits a stronger and healthier plant, one that generally is better able to withstand drought. Although it seems almost paradoxical it is quite true that in drought years on clay and clay loam soils farmers usually secure best yields from fields having the best and deepest drainage. Tile drainage is recognized as a profitable investment, so much so in fact that bankers often will lend money to enable the farmer to adopt the practice and thereby increase his yields.

Although it is difficult, if not impossible, to overdrain heavier soils, caution must be used in draining peat, muck, sandy, and sandy loam soils. These soils are low in water-holding capacity, and lowering the water too far beneath the surface may result in drying. The sandy soils are subject to wind erosion, and the peat and muck soils to blowing and fire if overdrained. Improper drainage of these soils may cause widespread

[2] See article, Hydraulics of Open Ditches, by the author, in Agricultural Engineering, May 1939, for further discussion.

Typical "before" condition of land that is to be drained.

damage, as in the Florida Everglades. In Indiana and Michigan controlled drainage by means of gate structures in ditches has been attempted in level areas of peat and muck soils with considerable success.

In many instances underdrainage is a direct benefit to soil conservation and erosion control. Underdrainage means the establishment of underground channels of water through which the ground water will flow and run off through tile drains. All the water that flows through the soil is conducted in a manner that is nonerosive. A well-drained field has better tilth and can absorb more rainfall. If a field is not underdrained any excess surface flow causes loss of soil through erosion. Such erosion is often serious, even on gently sloping fields that should be tile drained.

A well-drained field also conserves soil resources in still another way. The soil is not a dead, inert substance, but is teeming with living bacteria and organisms necessary and conducive to plant growth. Where poor drainage conditions exist and the water table is too near the surface, or where water "ponds" in fields after heavy rains, the situation is not conducive to efficient plant growth. The flooding of the soil drowns these bacteria, organisms, and plants and disturbs the equilibrium so that it may take a long time to rebuild a productive soil of good tilth. In considering the relationship of drainage to other phases of a complete farm program it is evident that proper drainage goes hand in hand with soil building and proper crop rotations.

The benefits of good drainage by way of sanitary conditions should not be overlooked. In some States the malaria-carrying *Anopheles* mosquito breeds on wet spots, but malaria can be prevented or reduced in rate in many places through proper drainage. Public-health benefits constitute one of the principal justifications for public support and interest in drainage activities. The proper drainage of feed lots is conducive to better health of farm animals. Good drainage of the farm homestead is essential for sanitation and clean living of the farm family.

The benefits of drainage often are well understood by the farmer, although occasionally it is desirable that he be furnished information on the beneficial results of underdrainage. Farmers themselves usually can provide excellent information on the effects of drainage on various crops on their farms. For example, they can tell the farm planner which fields are poorly drained, which spots flood out and approximately how often. Frequently, however, the farmer is at a loss in recommending a solution. He may attribute his drainage troubles to one cause when in reality there are several. He may claim that his drainage troubles are the result of the clearing out of ditches by farmers upstream, when in reality the drains serving his farm are inadequate. He may believe that his drainage difficulty is due to constriction of a ditch at one point and that he can relieve the situation by improving the channel for a short distance. In some instances this may be practicable but usually a more complete solution is needed than is apparent from a casual examination. Often the entire drainage system must be rehabilitated. Overestimating the adequacy of an outlet channel is another common error; frequently more extensive improvements are needed on the outlet channel than is realized by those affected by poor drainage conditions.

The experience of the writer, in dealing with farm drainage problems, is that although accurate information usually can be secured from the farmer as to the effect on crops of drainage practices and specific fields needing drainage, yet considerable caution must be

used in accepting remedies suggested by the farmer. This is of course in the nature of personal observation; other observers may have had other experiences.

The farm planner should become familiar with some of the fundamentals of planning for adequate drainage systems. An adequate outlet is the first essential. The outlet may be an artificial ditch or a natural channel. In either case, the capacity in relation to the watershed, the height, and frequency of floods should be considered. Recommended drainage curves have been supplied to each Soil Conservation Service region for general use, but it should be understood that where the watershed contains steep lands the rate of run-off will be higher and flooding will be more frequent. Often the adequacy of an outlet can be checked by determining from local residents the maximum flood heights, and by getting all information available regarding flood frequency. If the land to be drained lies slightly above the average annual flood heights of the outlet stream it is possible, ordinarily, to secure "good" agricultural drainage by providing adequate farm ditches to that outlet.

The farm planner will be called on to decide whether drainage should be provided by means of open ditches or by using tile drains. Some authorities contend that underground water will not flow off through open ditches as well as through tile drains, but evidence on this point is not conclusive. Except for higher first cost, tile drains generally are much superior to open drains for farm drainage. The chief disadvantages of open drains as compared with tile drains are that they cut up fields, occupy land that could be farmed, make cultivation more difficult, and entail maintenance problems. In some soils tile drains thus far have not proved economical; in such soils their use should be on a demonstrational basis until it is determined whether or not they can provide proper drainage.

Many soils are porous enough and have sufficient internal drainage so that underdraining is not absolutely necessary if good surface drainage is provided. In case of doubt it is advisable to try surface drains, with possibly a few lines of tile, until the economy of tile underdrainage is determined.

When using either tile or open drains on slightly undulating land it is often economical to plan the system so that the low swales are drained with random drains, which are less expensive than drains laid at regular intervals. In locating a drain it is a fundamental rule that it should be placed along the lowest points of a field.

Field ditches may be of the following types:

(1) Narrow ditches with nearly vertical sides, dug and maintained by hand.

(2) V-shaped ditches 2 to 3½ feet deep, dug and maintained by equipment such as a ditcher or grader

(3) Wide flat ditches in meadow crops, so constructed that they can be readily crossed by farm equipment.

(4) Larger drains which are dug by dragline excavators; such drains are economical where a medium-sized ditch is required.

Drains of poles, brush, stones, and lumber were used in early days for underdrains and all evidences point to the fact that the benefits of proper drainage were understood by early pioneers. The length of life of such drains was usually short, although occasionally some are discovered which are still operating. For at least 80 years tile drains have been the common type of underdrains and during this time the quality has been much improved.

An adequate outlet is particularly important for a tile drain. The ideal outlet permits free flow from a tile drain at all times, but this can seldom be secured. The farmer who is undertaking tile drainage should be certain that the outlet will not deteriorate or else that satisfactory provisions will be made for maintenance. Tile drainage is an expensive farm improvement and the entire investment may be lost if the outlet is not maintained.

Tile drainage is often successfully and economically established on farms by employing a random system following low spots. On flatter fields of heavy soils a random system may not be practicable, so that regular spacing of drains is necessary. In clay and clay loam soils that are successfully drained the tiles are placed from 40 to 70 feet apart and from 27 to 36 inches deep. No tile should be laid less than 27 inches deep. In lighter soils, the spacing may be as great as 150 to 200 feet and the depth as much as 42 inches. The tile system usually is designed to handle a run-off of one-quarter or three-eighths inch from the watershed area in 24 hours.

For the benefit of farm planners in particular, a general method of determining proper depth and spacing of tile drains based on soil analysis is badly needed, but unfortunately no index based on a sufficient number of soil types to justify widespread application has been worked out. Until some such method is developed we should attempt to build up the fund of factual material relative to the effectiveness of drains for the various soil types in each locality. Tile drainage has been widely used, and extensive systems have been installed with varying degrees of success.

Farm planners handling drainage problems must ferret out available information to apply to the soil types he encounters. Often the State Agricultural College is the best source of information regarding local drainage practices. Many State colleges have men who have been dealing with drainage problems for long periods of time; often their fund of information is very helpful.

The maintenance of an open ditch is the key to successful drainage of the farm lands it serves. All open drains deteriorate gradually, and thus they must be maintained effectively and regularly if farmers are to benefit through proper drainage. Poor maintenance results in large annual crop losses, and herein lies one of the difficult problems in connection with drainage systems. Much information is yet to be secured on proper drainage practices, but in spite of this deficiency the farm planner can pass on to the farmer many ideas for improving maintenance to keep the farm drainage system functioning properly. Some of these ways and means for recommendation by the farm planner are discussed in the following paragraphs.

In many places large open drains serve so many farms that it is impracticable for individual farmers or groups of farmers to maintain them. Such drains must be maintained by a legal drainage enterprise or as provided by State law. Drainage officials or county officials responsible for maintenance of such drains are subject to the wishes and demands of the farmer, so that if the farmers insist on proper maintenance they will get it. If a farmer is content to neglect mainteannce, in order to save annual taxes, officials may allow these large open drains to go without maintenance. The farm planner can assist in making the farmer aware of his drainage problem so that he will insist on public maintenance of outlet drains when it is needed.

Several practical methods of decreasing the silting of ditches have been tried out and found successful. Formerly it was common practice to allow field drains to run into open ditches at low level without protection at the point of drop, and this resulted in silt deposits and often in gully-type erosion. The improved practice used today is to establish vegetated runways at all points where surface water enters a ditch; where special problems must arise structures should be provided to avoid such erosion. Spoil banks should be placed well back from the edge of the ditch, and they should be leveled if the soil is suitable for cultivation and fits in with the farm plan.

On many farms there is considerable erosion on slopes of 1 to 3 percent. Farm planners should give this type of problem careful attention, as such areas often represent a farm's most valuable agricultural lands. It may be desirable to work out an erosion-control plan for such lands, not only to hold the soil in place but to try to reduce erosion debris to a minimum as an aid in economic maintenance of the drainage systems. A system of field drains with wide shallow sodded ditches may be used to minimize the silting of ditches. Open drains should be grassed, and controlled pasturage often helps in maintaining them. Where maintenance of drains is the direct responsibility of the farmer, the farm planner should help him to work out specific measures for keeping his drainage system in good condition as a part of the farm-conservation plan.

DISTRICT NOTES

The supervisors of the Kent Soil Conservation District, Md., consider drainage, bay-bank and shoreline erosion-control problems along Chesapeake Bay as a part of district work. This involves control of roadside erosion and erosion in adjacent fields caused by concentration of water drained from roads. In their last semiannual report the supervisors make this statement: "Both of these problems are worthy of effort * * * Treatment of shore line erosion would be largely experimental work to determine the most economical and effective means of prevention and control. Relative to roadside erosion, it is felt that closer cooperation with the State Roads Commission would improve the situation and some present erosive conditions could be reduced or eliminated."

The supervisors of the Fort Berthold Soil Conservation District, N. D., have purchased 160 acres of land from the commissioners of Mountrail County for the purpose of grass-seed production. Of course, the seed produced on this land will be used on farms in the district that are covered by a farm conservation plan and cooperative agreement between the respective farmers and the supervisors. The supervisors now hold a tax deed to this farm, the title to which will be cleared without cost to the district by the State's attorney of Mountrail County.

The governing body of the Leake County Soil Conservation District, Miss., recognizes the "need for some sort of a drainage program to help farmers open up some of the good land on 'A' slopes so that they could retire submarginal slopes with greater ease and security" and are working toward such a land-use adjustment program in connection with district work.

LAND RECLAMATION AND PASTURE INVESTIGATIONS ON ABANDONED AND SCRUBBY OAK AREAS

By HARRY M. ELWELL [1]

BECAUSE of erosion a high percentage of the cultivated fields in central Oklahoma (*2, 10*) are being abandoned. For this reason land-reclamation and pasture studies have been carried out within the past 8 years on a typical area of the cross-timbered section (*7*) of the State. These investigations were started in 1932 on about 110 acres of land leased by the Oklahoma Agricultural Experiment Station and operated cooperatively by the Soil Conservation Service. The area lies just east of the main farm at the Conservation Experiment Station near Guthrie. About 75 acres of this land was abandoned, and the remainder was covered with native scrubby oak and grass. An erosion survey showed that about 12 inches of the surface soil had been removed from the abandoned area during approximately 37 years of continuous cultivation. Various reports (*5, 9*) show results of the earlier findings, and the revegetative and gully-control experiment conducted on the abandoned portion was reported by Elwell, Slosser, and Daniel (*6*).

According to recent land-use information (*11*), 32.15 percent of the pasture land in Creek, Lincoln, Okfuskee, Seminole, Cleveland, Oklahoma, Pottawatomie, Pontotoc, and Coal Counties in Oklahoma is classed as woodland pasture. In eight townships of southeastern Logan County, woodland pastures occupy 47.22 percent of the total farm lands. The tree cover in the cross-timber area of the State consists mainly of blackjack oak (*Quercus marilandica*) and a small amount of post oak (*Quercus stellata*). This wood cover occurs in sparse to rather dense stands on land between the creeks and drainageways. The first photograph shows that usually this vegetation is intermingled with dense spots of native grass. These grasses make a very good growth where the tree competition is not too great.

The land-reclamation studies involved, first, the removal of scrubby oak from about 35 acres of this type of land in 1935-36. The cost of clearing such land is quite high although it varies, of course, with density of the stand. However, farmers adjacent to the station found that 10 to 16 ricks of firewood per acre were produced on similar land and that under average conditions such materials bring from $1 to $1.50 per rick. Thus it is thought that in most instances the return from the sale of the wood about meets the cost of removing the trees from the land.

After the original cover was removed, it was found that sprout growth from the stumps must be controlled. Burning these sprouts with kerosene torches was tried, but the cost was found to be approximately $3 per acre, and the practice also destroyed the grass around the stumps. Then the effect of goat grazing was observed on an adjacent farm and in this one instance it appeared that the herbage vegetation was so utilized along with the sprouts that the practice seemed to retard grass succession on the land formerly occupied by trees.

Several other methods also were tried out in efforts to minimize unfavorable competition by oak sprouts and at present clipping with a regular farm-type mowing machine appears to be the most satisfactory. This practice has been recommended by Aldous (*1*) in Kansas for controlling weeds and brush in pastures. He states, "This work was more effective when it was done at the low point of the organic food reserves." According to his findings this condition apparently occurs during the first part of May for a large proportion of the common weeds. The Agricultural Adjustment Administration (*12*) has approved payment of 25 cents per acre for mowing of noxious plants as an aid to range and pasture management during 1940. Although some sprouts remain at present, there has been little or no competiton from the oak plants where mowing was done about the middle of May and again the latter part of August. This indicates that the sprouts may be clipped at the same time the weeds and other noxious plants are mowed, without additional expense.

After the tree competition had been removed, the grass soon spread and provided a ground cover sufficient to prevent erosion. Evidence of this is seen in the fact that an average annual run-off of 1.23 percent was recorded during a 5-year period from a 2.5-acre watershed within the recently cleared area.

It is thought advisable that the cleared areas be used as a meadow for a few years, in order to minimize the

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Typical area of scrubby oak trees intermingled with native grass on the central cross-timbered soil of Oklahoma.

The seed produced by native grasses under favorable conditions will often spread and produce a good cover the first or second year after removal of scrubby oak competition.

likelihood of overutilization of the vegetation. If the grass is cut for hay early in August, most of the native plants will set a fair crop of seed before the season of frost in central Oklahoma. The information already obtained indicates that if the areas are protected from fires a good ground cover of native grass and enough forage to permit some grazing may be produced in 2 to 3 years under normal rainfall conditions.

According to the best information available (*6*), it may take about 25 years or longer for the native climax grasses to reestablish themselves under natural conditions on abandoned land. This no doubt is due largely to low fertility, low water-holding capacity, and the poor physical condition of the subsoil exposed by erosion. Revegetative experiments with light application of fertilizer on rowed sweetclover have been encouraging on the abandoned land. Lime was applied at the rate of 100 pounds per acre and either rock phosphate or superphosphate at the rate of 50 pounds per acre. The seed was sown in rows 3 feet apart. The yield of clover the second year was about a ton of forage per acre. In some trials a fair stand of blue grama was obtained from broadcast seeding at the rate of 20 pounds per acre following the sweetclover. This plant was the only species of 18 native grasses that produced a fair ground cover during 1936 and 1937.

In 1939 the entire farm of 110 acres was converted into a grazing experiment in cooperation with the Oklahoma Agricultural Experiment Station. Although the soils and plants on the virgin land were slightly higher in nitrogen and minerals than those on the eroded area (see table 1), in general the type of vegetation occupying this section of the State (*3, 4, 8*) is low in phosphorus and calcium. Since these elements are very essential in the growth of livestock, a mixture of equal parts of steamed bone meal, pow-

Grass cover the third year after removing scrubby oak, and after being grazed 119 days by 14 yearling steers.

TABLE 1.—*Quantity of grass consumed in summer grazing by steers, and analyses of vegetation and soils from submarginal areas and cleared woodland*

Type of land	Year*	Total plant cover consumed by cattle	Analyses**					
			Forage	Soil				
			Nitrogen	pH	Organic matter	Calcium	Magnesium	Available phosphorus
		Percent	*Percent*		*Percent*			
Abandoned (formerly cultivated about 37 years)	1939	10.19	0.468	7.20	0.73	Medium	High	Very low.
	1940	25.20						
Woodland (cleared 1935–36)	1939	20.79	.625	7.44	1.04	High	High	Very low.
	1940	67.12						
Virgin meadow	1939	None	.657	6.28	1.29	High	Very low	Very low.
	1940							

*During 1939, 14 steers were on pasture 119 days; in 1940, 20 steers, for a period of 153 days.
**Forage and soil analyses made by Agronomy Department ,Oklahoma A. and M. College, Stillwater, Okla.

dered limestone, and common salt was provided at a convenient location for the cattle. The animals used in the grazing tests ranged from medium- to good-quality yearling steers.

The original plans included grazing the pasture during the growing season, but because of delay in getting the experiment under way the first year, it was not until June 6, 1939, that 14 grade yearling steers were turned on to this farm to remain until October 3, a total of 119 days. The data in table 2 show a total gain of 2,716 pounds for all the steers, which is an average of 24.68 pounds of beef per acre. The average gain per head was 194 pounds, which is an average daily gain of 1.63 pounds per head. During the second test, in 1940, 20 steers occupied the same pasture from May 1 to October 1, or 153 days. They produced a total of 5,530 pounds of beef, or an average gain of 276.5 pounds each, which is a daily gain of 1.81 pounds per animal. This is an average of 50.27 pounds of beef per acre.

Several wire cages were placed over areas of the pasture, and the vegetation utilized by the steers was calculated by comparing the amount of grass in the protected areas to that in the grazed areas. The percentage of total plant cover consumed by the cattle

TABLE 2.—*Gains made by yearling steers grazed on 75 acres of land formerly abandoned from cultivation, and 35 acres of cleared scrubby woodland* (Progress report, 2 years only)*

	1939**	1940***
Number of animals	14	20
Grazing period.....days	119	153
Acres per steer	7.86	5.5
Selling weight (Oklahoma City).....pounds	9,072	15,330
Initial weight (Oklahoma City).....do	6,356	9,800
Total gain in weight.....do	2,716	5,530
Gain per acre.....do	24.68	50.27
Average daily gain per steer.....do	1.63	1.81

*Data collected by Bruce R. Taylor, assistant professor of animal husbandry, Oklahoma A. and M. College, Stillwater, Okla.
**Grazing period, June 6 to Oct. 3.
***Grazing period, May 1 to Oct. 1.

in 1939 on the eroded portion was 10.19, and on the virgin land 20.79; while the consumption in 1940 was 25.20 and 67.12 percent, respectively.

It should be realized that in the first test the steers were placed on the pasture at least 40 days after the grazing season had started. These same steers had no doubt been on grass somewhere during this period and had made some weight gain thereby. The low utilization of vegetation indicates that a heavier stocking than 7.86 acres per steer might have given greater profit. Because of this the number of animals was increased the second year to 5.5 acres per steer. From observation and the amount of vegetation consumed, it appears that the carrying capacity of the pasture was reached under its present conditions.

When the amount of beef produced per acre and the variation in the price of cattle the last few years are taken into consideration, it seems probable that a gross income of $1 to $4 per acre might have been received. This is a fair return, considering the fact that such land has an average sale value of approximately $8 per acre. In any event, the fact remains that the average pounds of beef per acre produced by medium- to good-quality yearling stockers was increased from 24.68 in 1939 to 50.27 in 1940, an increase sufficient to place this formerly useless land on a profitable basis of operation.

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PLANTING LESPEDEZA SERICEA WITH BLACK LOCUST

By J. A. JOHNSON [1]

THE growing of two types of plants on a single area with the desired results and without injury to either is unusual, but such a planting is especially worth while if it helps the farmer to solve a land-use problem in a practical way. This article tells briefly of successful demonstrations in the growing of black locust (*Robinia pseudoacacia*) and *Lespedeza sericea* on Mississippi farms in two erosion-control demonstration projects and one CCC camp area.

The Soil Conservation Service has long recommended the planting of black locust on eroded lands in the Southeastern States for control of erosion and production of durable fence posts. On Mississippi farms where fence maintenance is a part of the soil conservation plan it has been the practice to devote to black locust 1 acre out of every 100 acres of such land. In this way the farmer could produce sufficient fence posts without incurring an excessive labor load or an oversupply of posts. The same general rule is now being followed by farmers in Mississippi soil conservation districts.

In the spring of 1936 a number of locust areas on farms in the Oakey Woods Creek demonstration area near Laurel, Miss., were interplanted with *L. sericea* in an effort to improve the ground cover and increase the variety and quantity of food for wildlife. The plantings gave indications of ultimate success the first season, but there were several questions to be answered before foresters and biologists were willing to recommend the combination generally. Is the planting of *L. sericea* with locust an improvement over planting locust alone for the control of erosion? Does *L. sericea* compete with locust for moisture and plant food to the detriment of the latter? How long will *L. sericea* be able to maintain itself under a rapidly developing locust stand? Is wildlife habitat im-

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A combination of black locust and Lespedeza sericea provides better erosion control, adds shelter and food for wildlife. This is how the two look in the third growing season. Although not evident in this picture, a complete stand of sericea spreads to the middles as a result of natural reseeding.

proved by planting *L. sericea* with the trees?

In order to obtain more complete answers, the author and project foresters established an additional number of these combination areas on farms in the Hell and Mud Creeks demonstration project near New Albany, Miss., in the spring of 1938. Almost without exception, good stands of both plants were successfully established.

A study of these areas over a 3-year period, and intermittent observations of the older areas in the demonstration project at Laurel and the CCC-camp demonstration area at Collins, appear to justify the following conclusions:

(1) *L. sericea* with locust improves the erosion-control value of the planting because a close ground cover is more quickly obtained. This is particularly true in winter when the heavier leaf mulch of *L. sericea* is needed to supplement the very light locust mulch.

(2) Locust does not suffer in growth as a result of competition from *L. sericea*. In fact, the opposite appears to be true. At New Albany where the areas were closely evaluated, locust plantings containing *L. sericea* are as good or better than those without it.

(3) *L. sericea* is maintaining itself in 3- to 5-year stands of locust with a vigor indicative of a long existence, possibly even to the point of permanency.

(4) As to whether or not the areas actually offer an improved wildlife habitat, it is apparent that a careful census of treated and untreated areas will be necessary before an authoritative statement can be made. The observations indicate, however, that the black locust-*L. sericea* areas are useful to rabbits, quail, and small birds. It was reported that quail made good use of the areas in the Laurel project during the nesting season.

Several methods of establishing the plants in combination have beer tried. The most practicable involves contour beds thrown up at 6-foot intervals when the land is prepared for tree planting. The beds are made by opening a furrow with a turning plow and then bedding back on this open furrow with at least two complete rounds with the same plow. This gives a firm, deep bed with no air pockets after it has been settled by one or more soaking rains. The young locust seedlings were set 6 feet apart in the center of the firmed bed. If they were set before March, the *L. sericea* seed was sown at a later date; if planted during late March or early April, the *L. sericea* was sown immediately following the tree planting. A very shallow trench was made with a hoe along the top of the bed between the trees so that the seed could be confined to a narrow strip. The *L. sericea* was sprinkled in this drill in the same manner as turnip seed is sown, except that they were not covered. About 2 pounds of scarified seed was used for each acre of trees.

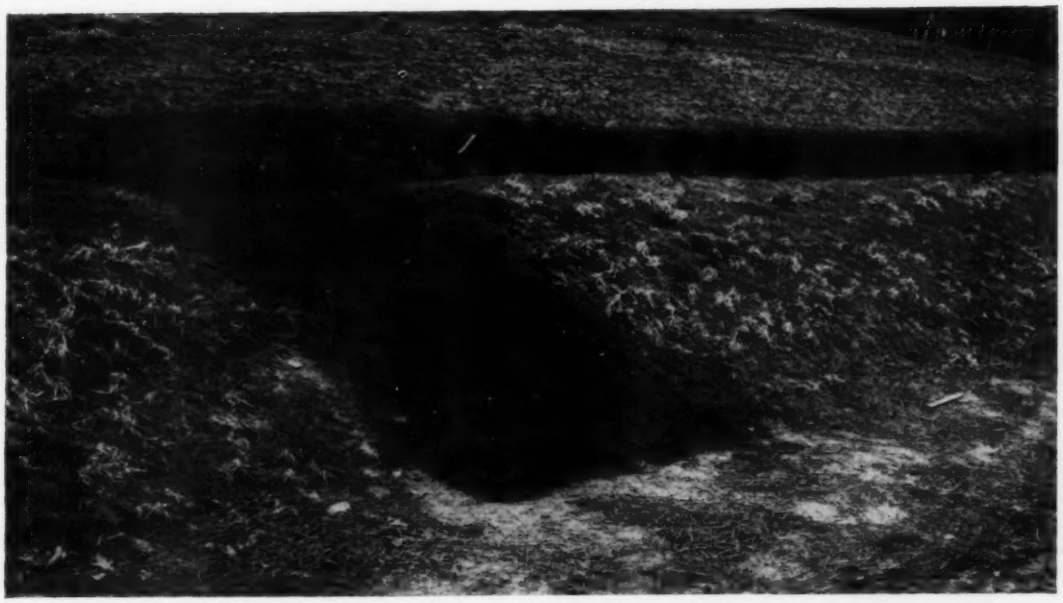
Later in the spring, when the trees first began to send out feeder roots, a furrow was opened on each side of the planted bed. Compost or commercial fertilizer was spread in these open furrows and covered by plowing out the middles between the beds.

Cultivation for one or more seasons, and fertilization, are essential on most soil types to ensure adequate growth of locust, even on less-eroded soils. Because of this, the method of planting described above has

(*Continued on p. 334*)

PROTECTING THE BACK SLOPE OF INTERCEPTION DITCHES

By CHARLES B. SULLIVAN [1]



An example of sod waterway construction, from temporary furrow to bottom of diversion ditch.

STABILIZING the back slope of interception ditches frequently presents a difficult and often discouraging problem to both agronomists and engineers. Interception ditches invariably are located in exposed sites on slopes. When the raw surface of a newly constructed ditch is subjected to rains of any notable intensity, the back slope becomes rilled and often the channel of the ditch becomes silted. The severe rilling of a newly seeded back slope necessitates reseeding under unfavorable conditions and sometimes the process of seeding has to be repeated several times before a stand of vegetation can be established.

Of equal seriousness is damage to the designed cross section of the ditch by rilling, silting, and scouring. However painstakingly designed or effectively constructed a ditch may be, a single intense storm while the ditch is unprotected by vegetation may cause a serious modification of the cross section and lessen considerably the effectiveness of the structure. Also, in such circumstances the discharge of silt from the unprotected site augments the silting damage to streams lower in the watershed.

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A system for intercepting run-off from the slope above ditches, to prevent rilling of newly seeded back slopes, has been effectively and extensively used in Lancaster and York Counties, Pa., since the summer of 1938. A small gutter is constructed at the junction of the back slope and the filter strip, and intercepted run-off is vented over sod inlaid in the back slope into the main ditch channel.

When the construction of a ditch has been completed, the gutter is made by using either a plow or a terracing blade. The former has the disadvantage of leaving a land side that will tend to slough, while the latter effects a well-rounded upper side that will handle run-off with the least amount of soil loss. Passing a spiked plank harrow over the gutter insures a satisfactory seed bed.

The continuity of this back-slope gutter is interrupted at intervals by sod outlets inlaid in the back slope at strategic points. Oftentimes such sod waterways down the back slope are necessary whether or not this method is used, as for example where an old gully concentrates water that would continue to cut into the back slope of the ditch. By means of these sod outlets at intervals of approximately 200 or 300

feet, run-off is discharged safely into the main channel of the diversion ditch.

The accompanying photograph shows the broad details of construction of both the back slope gutter and the inlaid sod waterway down the back slope to the channel of the ditch. It will be noted that the sod waterway does not continue across the channel but extends only about 18 inches into the channel. This extension is sufficient to break the force of water entering the channel over the sod and eliminates the dam and over-fall effect caused by sodding completely across the channel. As can be seen in the picture, ample protection is afforded this ditch by the gutter. The ditch was seeded September 13, 1938; the photograph was taken early in the Spring of 1939. Several severe storms had been experienced in the interval.

In addition to giving protection to back slopes while vegetation is becoming established, this system is valuable to prevent silting when filter strips are plowed for renewal.

A SAFER USE OF LAND

MORE proof is accumulating that silage from perennial soil-building forage crops such as alfalfa and timothy is cheaper than silage from corn, a soil-depleting crop. During 1936–37 northern New Jersey corn silage, yielding 11 tons per acre, cost $4.97 per ton to produce; timothy silage yielding 7 tons cost $2.17 per ton; and clover and timothy silage, yielding 9 tons, cost $3.11 per ton. In addition the corn silage cost $2.07 per ton to harvest, while the grass silage cost only $1.85 per ton. Including 60 cents per ton for molasses, the grass silage was still considerably cheaper than the corn silage and its feeding value was higher. The carotene value of the timothy silage was higher than that of the best dehydrated alfalfa hay. Dairy heifers thrived on a sole ration of this timothy silage, gaining an average of two-thirds of a pound a day per head. The experimental work was done at the Sussex branch of the New Jersey Experiment Station.

Since some are of the opinion that such data may not apply to the Corn Belt, it is very important to note that in 1939 the Ohio Agricultural Experiment Station obtained data from 120 farms in comparing the cost of producing alfalfa, soybean, and corn silage. First cutting of alfalfa, averaging 5 tons of silage per acre cost 50 cents per ton prior to harvest and $2.19 for harvesting. The additional charge of 60 cents for adding 50 pounds of molasses per ton, made a total cost of $2.69 per ton.

The cost of producing an acre of alfalfa was $9.15, of which $6.67 was charged to the second and third cuttings which were used for hay. Soybeans yielded 7½ tons of silage per acre which cost a total of $3.91 per ton including molasses. Corn, yielding 9 tons per acre, cost $1.95 to produce and $1.19 to harvest, making a total of $3.14 per ton or 17 percent more than the alfalfa silage.

In addition to the cheaper cost, the grass and legume silages have the advantage of a higher protein content and of being soil-building rather than soil-depleting crops. It is not unusual for molasses to sell at prices which put it on a competitive basis with corn. Hence, the molasses might be considered as an added value rather than as a charge against the alfalfa.

The making of silage from perennial grasses and legumes fits admirably into the trend toward grassland farming and meets the urgent need for cheaper methods of producing meat, milk, and other livestock products. With good management and the use of sufficient mineral fertilizers, productive silage meadows can be maintained on land that presents many difficulties for clean-tilled or other annual crop farming. Likewise, in some instances the making of silage from grass will permit the advantageous use of longer rotations such as 1 year of corn, 1 of small grain and 3 or 4 years of grass. Numbers of fields in grass also facilitate rotation grazing in addition to supplying hay and silage for winter feed and other periods when grazing is not adequate to supply livestock feed.

Additional information on this subject may be found in New Jersey Circular 374, entitled "Timothy Silage as a Dairy Feed," and the July-August 1940 issue of the Ohio Bimonthly Bulletin.—A. T. Semple.

LESPEDEZA SERICEA—BLACK LOCUST

(*Continued from p. 332*)

several advantages over broadcasting seed on the beds just after the trees have been set, or sowing in the middles following cultivation. In the first place, the *L. sericea* is given an equal start with the trees without handicapping cultivation of the latter. Early sowing is desirable to ensure satisfactory establishment of *L. sericea* during the first growing season, particularly because it is a slow-maturing perennial. Second, less seed is needed for this method; and in the third place, the ground cover obtained is sufficiently dense to reduce run-off, yet not so rank as to compete seriously with the young locust trees for moisture and plant food. *L. sericea* begins seeding into the middles after cultivation is discontinued, but the indications are that the ground cover will never become so dense as to be objectionable to wildlife.

KUDZU, A SOIL BUILDER

By R. P. Bartholomew [1]

KUDZU is a good soil-improving crop where it is adapted to the environmental conditions. Just what limitations exist in its adaptability and what special precautions must be taken in establishing and handling the crop still appear to be a matter of personal preference and experience.

Although experiments with kudzu in Arkansas have not always been as successful as desirable, the results of an experiment at the Fruit and Truck Experiment Station near Hope, on a depleted and eroded Ruston fine sandy loam, prove the soil-building qualities of kudzu.

An experimental planting of crowns was made 10 years ago on a ⅛-acre plot to determine whether or not kudzu could be established on poor soil. No fertilization was given at the time, although designated parts of the planting have since been fertilized to determine the effect of the fertilizer on the growth of the plant. No yields have been taken and the leaves and vines have been permitted to accumulate as they died.

In June 1940 samples of soil were taken from the unfertilized area in which the kudzu was growing, from an adjacent unfertilized area that had been planted continuously to cotton for 6 years, and from an adjoining area that for 10 years had been devoted to Bermuda grass and lespedeza as a soil protecting cover.

The 4-inch layer of organic matter in varying stages of decomposition which has accumulated in 10 years in the kudzu planting can be seen in the accompanying photograph. This dense mat of organic matter would be in itself a good cover to prevent soil washing. The incorporation of the organic layer plays an important part in the rebuilding of the soil.

The results of analyses on the soil samples for total nitrogen content show the value of two legumes, kudzu and lespedeza, in soil conservation practices. The surface soil, 6⅔ inches deep where kudzu was grown, contained 1,240 pounds of nitrogen per acre. In contrast the soil cultivated continuously to cotton contained only 780 pounds of nitrogen per acre 6⅔ inches deep. The soil devoted to Bermuda grass and lespedeza contained 1,280 pounds of nitrogen in the surface layer. An average difference of almost 500 pounds of nitrogen per acre can be attributed to the legumes.

[1] Agronomist, Arkansas Experiment Station. Adapted from Research Paper 686, Journal Series, University of Arkansas.

BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neall Faris

THE BIOCHEMISTRY OF SYMBIOTIC NITROGEN FIXATION. By Perry W. Wilson. University of Wisconsin Press, Madison. 1940.

Although this new book is produced by a true scientist, and in spite of its precise title, one does not need to be a biological chemist, or any kind of chemist, to understand its implications—that human and animal populations require protein, that the amount of nitrogen in the soil limits protein in a given crop, that nitrogen is the element about which proteins are constructed, and that the "nitrogen budget" of the United States is badly in need of balancing. According to Professor Wilson's analysis, the leaks in the nitrogen cycle through erosion, leaching, sewage waste, etc., in this country could not be plugged up had we at our disposal all the synthetic nitrogen in the world. It is clear throughout the volume that the author is of the opinion that we must take care of leaching and erosion losses and at the same time gain nitrogen through every possible means in order to maintain the green plant upon which permanence of our human society is dependent. The biological fixation of atmospheric nitrogen through the association of leguminous plants with bacteria is the subject of the 300-page monograph which, incidentally, includes one of the best reference lists to be found anywhere—there are 730 entries.

The Lipman and Conybeare "Balance Sheet of Nitrogen for Agricultural Areas of the United States" is shown in chart form and pointed out as evidence that "there must be a reform in land policy if bankruptcy is not to ensue"—nitrogen bankruptcy. It is through his discussion of this deficit in the "nitrogen budget" of our country that Professor Wilson leads to a most interesting historical account of leguminous plants in world agriculture from ancient days to the present. Varro (116–28 B. C.) is quoted on legume cultivation; Columella on alfalfa; Yarranton on clover in England in the 1600's; Davy on agricultural chemistry in the early 1800's; Boussingault, who converted his Alsatian farm into the first agricultural experiment station, on his notable experiments on fixation of atmospheric nitrogen. Many curious facts are brought out in this historical section, expecially many curious errors; yet it does give a vivid impression of the slow evolution of scientific thinking.

The author's presentation of the many controversial studies of the past century and a half leads adroitly to the present decade with its problem of discovering the real facts about "how the living organism transforms with apparent ease the inert nitrogen molecule into reactive compounds * * *" The book is exceptionally well balanced, and certainly the subject as presented is a challenge to scientific thinking. Professor Wilson's style of writing is sympathetic even as he chides research scientists for refusing to take the leadership in great problems of the day; it is persuasive in that it gently leads on even the layman reader in the desire to understand the role of nitrogen in human existence.

Over 200 pages of the book, the main part of it, are devoted to what is now known about the "partnership" that apparently exists between leguminous plants and root nodule bacteria in the process called nitrogen fixation. Professor Wilson approaches the subject in straightforward manner, by discussing separately the characteristics as revealed thus far by investigation and experimentation of the bacteria that cause root nodules to form. Then in a chapter, "Interaction of Host and Bacteria," he presents in great detail the "major steps by which the bacteria invade the plant, form nodules, and fix nitrogen." A chapter immediately following summarizes recent studies of nitrogen fixation by the root nodule bacteria and the leguminous plant. The author allows three possibilities with respect to the mechanism of the process: First, that the bacteria provide nitrogen to the plant in exchange for carbohydrate from the plant. Second, that the bacteria in invading the plant "merely arouse in the cells of the host a function that would otherwise remain dormant." Third, that the fixation process is a "truly cooperative function of the two organisms," and that, without the other, each would be helpless in the transfer of atmospheric nitrogen to the soil.

These three possibilities are carried through several chapters discussing the known facts about the means by which the bacteria invade the plant, the relationship between them, the agent of fixation, and the properties of the enzyme system. These chapters will interest the research scientist chiefly; yet it cannot be denied that there is something inspiring even to the layman in the search for that thus far unknown quantity, the mechanism of nitrogen fixation.

This book is truly well planned. Throughout those chapters dealing with biochemical experiments Professor Wilson has consciously avoided reference to practical application of results. But in his final chapter, a long one, he has presented the agronomic features of the use of legumes and their relation to biochemical research. The associated growth of legumes and nonlegumes is discussed at some length and includes field results of corn and soybeans grown together, oats and peas grown for hay, vetch and oats, wheat and vetch, and other combinations whereby it is hoped that in time more can be learned about the excretion of nitrogen by a growing legume to an associated nonlegume.

Pasture mixtures are given a special section, not as to whether or not mixtures are desirable but, rather, what are some of the mixtures most desirable for improving soil structure and increasing soil organic matter, for controlling erosion and run-off water most effectively, for higher protein and other food elements, for greater yield, and for maintenance of superior species. Results of experiments, some of them controversial, on free versus combined nitrogen in mixed cropping and for nutrition of legumes are given also in this chapter on practical applications, while in his concluding observations Professor Wilson points out the importance of solving within the near future some of the still puzzling problems with regard to nitrogen fixation by legumes and the effects of other chemical and biological processes upon the mechanism. Thirty-four plates, 27 figures in the form of graphs, charts, and drawings illustrate this volume.

DRAINAGE AND FLOOD-CONTROL ENGINEERING, 2d edition. By George W. Pickels. New York and London. 1941.

The first edition of this book appeared 15 years ago. It was designed as a text for courses in land reclamation by drainage. The new edition is only about 75 pages longer, but deletion of a whole chapter on excavating machinery, and other briefer sections, has made way for 125 pages of new or revised material important in design of drainage and flood-control systems and structures.

The chapter on precipitation now includes analyses of excessive precipitation storms up to and including the New England storm of March 1936 and the disastrous Ohio Valley flood of 1937. The storms are divided into the northern and southern groups and are discussed as to geographical and seasonal distribution, area covered, depth, and the relationship of these factors in estimating flood run-off expectancy. Frequency formulas by Meyer, Schafmayer and Grant, Yarnell, and Bernard are compared for accuracy and usefulness in making intensity-frequency charts.

Run-off is treated from the point of view of flood and property damage prevention solely, and the volume is valuable chiefly as a compilation of formulas having to do with flood run-off, stream discharge, water flow in drains and channels, pumping plants for drainage districts, and reservoir location and capacity for prevention of floods. A chapter on drainage law is designed to acquaint engineering students with the general features of the legal phases of drainage districts. Reference lists are given with some of the chapters, and although they have been brought up to date in only a few instances they are nevertheless useful in tracing measurement and design data and heavy precipitation frequency in the United States. About 150 charts, maps, and photographs illustrate the text throughout.

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